The nexus between water sufficiency and water-borne diseases in cities in Africa

STUDY PROTOCOL

The nexus between water sufficiency and water-borne diseases in cities in Africa: a scoping review protocol [version 1; peer review: 2 approved with reservations]

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Abstract

Introduction: Currently, an estimated two thirds of the world population is water insufficient. As of 2015, one out of every five people in developing countries do not have access to clean sufficient drinking water. In an attempt to share the limited resource, water has been distributed at irregular intervals in cities in developing countries. Residents in these cities seek alternative water sources to supplement the inadequate water supplied. Some of these alternative sources of water are unsafe for human consumption, leading to an increased risk in water-borne diseases. Africa contributes to 53% of the diarrheal cases reported globally, with contaminated drinking water being the main source of transmission. Water-borne diseases like diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus are a major public health concern. The main objective of this scoping review is to map the available evidence to understand the sources of water among residents in cities in Africa and the relationship between clean water sufficiency and water-borne diseases in urban Africa.
Methods and analysis: The search strategy will identify studies published in scientific journals and reports that are directly relevant to African cities that have a population of more than half a million residents as of 2014 AND studies on the ten emerging water-borne diseases, which are diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus.
Ethics and dissemination: This scoping review did not require any formal ethical approval. The findings will be published in a peer-reviewed journal.

Open Peer Review

Reviewer Status ? ?

	Invited Reviewers	
	1	**2**
version 1 05 May 2020	? report	? report

1. **Batsirai Majuru**, World Health Organization, Geneva, Switzerland
2. **David Musoke**, Makerere University College of Health Sciences, Kampala, Uganda

Any reports and responses or comments on the article can be found at the end of the article.

Keywords
Water-borne diseases, water insufficiency, scoping review, African cities, water supply

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Competing interests: No competing interests were disclosed.

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Introduction

By 2050, the population in sub-Saharan Africa is projected to double, with cities experiencing an annual growth rate of more than 4%[1]. However, the fast rate of urbanization has not been reflected in the rate of infrastructure growth and this has affected the capacity of most cities to provide basic amenities, leading to challenges including water insecurity, poor housing and inadequate social amenities[2]. Water is an important natural resource which lies at the nexus of food security, poverty reduction, economic growth, energy production and human health[3,4]. Urbanization will accelerate demand for water[2,5].

The 2030 United Nations Sustainable Development Goal 6 aims to attain sustainable management and availability of sufficient clean water and sanitation for all[6]. Currently, an estimated 40% of the global population is water insufficient[6]. The minimum water access requirement per person per day is 50 litres[7]. However, as of 2015, one out of every five people in developing countries do not have access to clean sufficient drinking water[8]. In an attempt to share the limited resource, water has been distributed in cities in developing countries at irregular intervals[9]. To cope with the irregular supply, residents in the cities have responded to these challenges by seeking alternative sources of water, some of which are unsafe for human consumption, leading to an increased risk of water-borne diseases[10,11].

Africa contributes to almost half (53%) of the diarrheal cases reported globally, with contaminated drinking water being the main source of transmission[12,13]. Water-borne diseases like diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus are a major public health concern[12,14]. As of 2010, cholera contributed to two deaths per 100,000 people and in 2014, diarrhea contributed to 20 deaths per 100,000 children under the age of five years, with unsafe water being a key risk factor[13,15].

The main objective of this scoping review is to map the available evidence to understand the sources of water among residents in cities in Africa and the relationship between clean water sufficiency and water-borne diseases in urban Africa. This will be achieved by synthesising findings of studies that have been written or published on: a) water sufficiency in cities within Africa; b) consequences of rapid urbanization on water sufficiency in African cities; and c) the linkages between water sufficiency and water-borne diseases in Africa. This scoping review will primarily seek to answer the following question: "what is the water sufficiency in cities in Africa and what is the correlation with water-borne diseases?"

This scoping review will identify the knowledge gaps and areas that need further research and contribute towards informing policies that help Africa achieve one of its Agenda 2063 aspirations on urban populations with adequate basic necessities[16].

Protocol

The scoping review will use the Joanna Briggs Institute methodology guidance for scoping reviews[17] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension guidelines for conducting scoping reviews[18,19].

Inclusion criteria

We will include the following types of papers:

1) Studies describing the water sufficiency or water situation in cities (urban areas with greater than half a million residents) in the African Union member states. Since the classification of a city and urban environments is not standardized[2], we use the population number of areas with >0.5 million people to be consistent with the UN report that estimates one in every three people will reside in cities with at least half a million inhabitants by 2030[20]. The list of the cities that meet this criterion have been selected from the United Nations World Urbanization Prospects of 2014[21]. Figure 1 shows a map of countries in Africa with the number of cities with a population >0.5 million.

2) Studies on water-borne diseases in cities in the African Union member states. We will focus on the ten emerging water-borne diseases, which are diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus[12,14].

3) Studies published in scientific journals or grey literature from government or non-governmental organizations.

Exclusion criteria

1) Studies conducted in rural areas or cities that have a population less than 500,000

2) Studies conducted in other continents other than the member states of the African Union

3) Studies not written in the English or French language

4) Systematic reviews

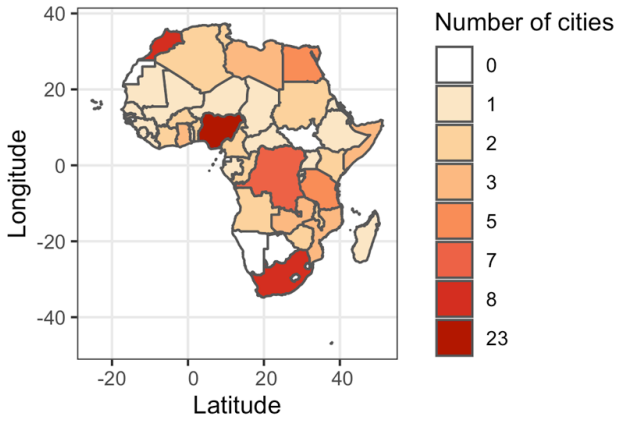

Figure 1. Member countries in the African Union and the number of cities with a population greater than half a million residents as of 2014. Source of data: United Nations World Urbanization Prospects, 2014[22].

Information sources and search strategy

Comprehensive literature searches will be done in Embase, MEDLINE, Web of Science and Google Scholar databases. The four databases have been identified as the optimal combination of databases that will guarantee adequate coverage of studies for literature searches[23].

The search strategy will take a three step process. The first step will involve carrying out a limited search in MEDLINE, Embase and Web of Science databases to analyse the text words and index terms that are used to describe the articles. The second step will then include a search in all the databases using the keywords and the index terms. In the final step, we will go through the references to identify key articles that might have been missed in the first two steps. The search terms used in the study are seen in Table 1.

Study selection

Once searches have been done in the databases, the title and abstracts will be extracted from the articles. Duplicates will be removed, and the review team will screen the studies using two levels: inital screening and full-text screening. During the initial screening process, three reviewers will read the abstracts of the studies captured by the search terms and weigh them using the inclusion criteria. To ensure consistency in the inclusion criteria, 10% of all the studies will be randomly selected and independently reviewed by two other reviewers. Any inconsistency between the primary and secondary reviewers will be discussed and a consensus reached.

Full text articles will be obtained for the studies that pass the initial screening stage. A Microsoft Excel version 16.36 spreadsheet will be used to store the data that will be extracted independently in the full text screening process. Table 2 shows the data that will be extracted. Of the data extracted, 10% will be randomly selected and independently reviewed by two other reviewers. Any consistencies among the reviewers will be discussed and an agreement will be reached.

The relevance of the studies in answering the research objective will be identified and studies that are not relevant will be removed and a reason for excluding the study will be recorded. In this stage, another 10% of the studies will be sampled and shared with the secondary reviewer who will exclude or include the studies based on their relevance to the study objective. Consensus will be reached for any discrepancies in the studies among the four reviewers.

Presentation of results

If there are enough studies designed in a similar way reporting on effect of water deficiency on health outcomes in a consistent manner, we will then be able to calculate heterogeneity (I^2) for the subset of included studies that follow a similar design. The index of heterogeneity (I^2 statistic) will be calculated from the sum of the squared deviations of the estimate of each study from the overall estimate and weighted by the influence of the study on the calculation of the overall estimate. We will look at the risk bias in the study level and characterize whether the metrics of water scarcity and health are a representative of the whole urban population or only a subgroup. We will use R software version 3.6.1 to carry out the analysis[24].

Cluster analysis will be performed to bring similar studies together using agglomerative hierarchical clustering using Ward's method, which is used in other scoping reviews[25]. The optimal number of clusters will be chosen to ensure the inner homogeneousness and external heterogeneousness of a cluster is balanced.

Table 1. Search terms that will be used to select studies from the different electronic databases and research repositories.

Parameter	Search terms
Population	Huambo OR Luanda OR Cotonou OR "Abomey-Calavi" OR "Abomey Calavi" OR Ouagadougou OR Bobo-Dioulasso OR "Bobo Dioulasso" OR Bunjumbura OR Younde OR Yaounde OR Douala OR Bangui OR Ndjamena OR Brazaville OR Pointe-Noire OR "PointeNoire" OR Abidjan OR Bouake OR Kinsasha OR Cairo OR "Al Qahirah" OR Al-Qahirah OR Alexandria OR "Al-Iskandariyah" OR "Al Iskandariyah" OR "Port Said" OR "Bur Said" OR "Addis Ababa" OR Libreville OR Banjul OR Accra OR Kumasi OR Conakry OR Nairobi OR Mombasa OR Monrovia OR Antananarivo OR Lilongwe OR "Blantyre-Limbe" OR "Blantyre Limbe" OR Bamako OR Nouakchott OR Casablanca OR "Dar-el-Beida" OR "Dar el Beida" OR Rabat OR Nampula OR Tetouan OR Fes OR Marrakech OR Tangier OR Tanger OR Maknes OR Meknes OR Agadir OR Maputo OR Matola OR Niamey OR Lagos OR Kaduna OR Akure OR Kano OR Abuja OR Aba OR Kigali OR Dakar OR Freetown OR CapeTown OR Durban OR Pretoria OR "Port Elizabeth" OR Bloemfontein OR "Dar es Salaam" OR Arusha OR Mbeya OR Lome OR Kampala OR Kitwe OR Lusaka OR Harare OR Bulawayo OR "Benin City" OR Enugu OR Ibadan OR Ikorodu OR Ilorin OR Jos OR Maiduguri OR Nnewi OR Onitsha OR Oshogbo OR Owerri OR "Port Harcourt" OR Sokoto OR Umuahia OR Oyo OR Warri OR Zaria OR Hargeysa OR Merca OR Mogadishu OR Muqdisho OR Johannesburg OR Soshanguve OR Vereeniging OR Khartoum OR "Al-Khartum" OR "Al Khartum" OR Nyala OR Safaqis OR Tunis OR Mwanza OR Zanzibar OR Ndola OR Algiers OR "El Djazair" OR Wahran OR Oran OR Bukavu OR Kananga OR Kisangani OR Lubumbashi OR "Mbuji-Mayi" OR "Mbuji Mayi" OR Tshikapa OR Djibouti OR "Al-Mansurah" OR "Al Mansurah" OR "As-Suways" OR "As Suways" OR Asmara OR "Sekondi Takoradi" OR Banghazi OR Misratah OR Tarabulus OR Tripoli
	AND
Exposure	water AND (scarc* OR intermittent OR break* OR ratio* OR deficit OR deficien* OR unavailab* OR continu* OR interrupt* OR stress OR supply OR sufficien* OR insufficien*)
	AND
Outcome	"water borne" OR "water-borne" OR cholera OR typhoid OR diarrhea* OR diarrhoea OR amoebiasis OR dysentery OR gastroenteritis OR cryptosporidi* OR cyclosporiasis OR giardiasis OR "guinea worm" OR "guinea worms" OR rotavirus

Table 2. Variables to be extracted from the articles for full-text screening.

	Variable	Details
1	Authors	Authors of the article
2	Publication type	Thesis, article
3	Title of the article	Full title
4	Year of publication	Year the article was published or written
5	Geographical scope of the study	City / cities the study was conducted
6	Study type	
7	Duration of the study (if applicable)	
8	Rate of urbanization	Metric, population of the city
9	Water demand / supply	Main water source, main water distributor, water demand
10	Water sufficiency	Frequency of water sufficiency, water rationing
11	Water-borne diseases	Diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm, rotavirus
12	Water-borne disease cases	Lab-confirmed / self-reported / clinically diagnosed
13	Water sufficiency	Metric, proportion of urban population with sufficient water supply, proportion of urban population with insufficient water supply
14	Main source of water scarcity metric	Consumer / service provider
15	Proportion of population with water-borne diseases	Metric
16	Area proposed for future research	

The study locations will be geocoded, and the data will be presented using digital maps that will depict the water sufficiency in these different cities and compare this with the World Resource Institute Aqueduct Global map[26], which depicts water stress for the countries in our study. Hotspot maps of the number of studies that have been carried out on waterborne diseases in the different cities will be presented and this will be compared with the water sufficiency maps to observe whether the same cities that have high cases of waterborne diseases are the same cities that have high water insufficiency. These maps will enable researchers to identify areas that have gaps in knowledge and identify future research needs.

Ethics and dissemination

The study did not require any ethical approval. The findings will be published in a scientific peer-reviewed journal.

Study status

Currently, we are doing the literature searches in the MEDLINE, Embase, Web of Science and Google Scholar databases and extracting the titles and abstracts from the articles which will be used in the initial screening process.

Data availability

No data are associated with this article.

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Publisher Full Text

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Publisher Full Text

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Reference Source

Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 24 August 2020

https://doi.org/10.21956/aasopenres.14158.r27733

?

David Musoke

Department of Disease Control and Environmental Health, School of Public Health, Makerere University College of Health Sciences, Kampala, Uganda

Generally, this is a well written protocol for the scoping review which is likely to generate key information concerning water and related diseases in cities in Africa. However, my main concern as detailed below is the need to explore other water indicators beyond sufficiency as they also contribute to water borne diseases.

Abstract:

- The background in the abstract is very wordy and therefore can be made more succinct.
- Use of statistics in the background of an abstract is discouraged due to the inability to cite accordingly.

Background:

- Whereas the background has focused on water sufficiency (quantity), it is important for the authors to consider describing other key water indicators such as coverage, quality, cost and continuity that also contribute to the occurrence of water borne diseases.
- The background may be strengthened by providing information on the various sources of water used in urban settings in Africa, both improved and unimproved.
- Water statistics for 2015 are used yet more recent literature is available.
- Whereas the study aim is on water sufficiency, other parameters as noted above have a direct contribution to water borne diseases. It is therefore not clear how these parameters are to be considered in the scoping review.

Protocol:

- In the inclusion criteria, other water indicators noted above should be considered.

- The exclusion criteria in principle should not be the opposite of the inclusion criteria but rather any predefined conditions that will be used omit any studies that would have met the inclusion criteria.
- The exposure search terms as well as variables (Table 2) may also include the various water indicators beyond quantity.
- The use of the term 'emerging diseases' may need to be justified.
- The choice of selection of the 10 'diseases' also needs to be justified.
- The outcome and independent variables to be considered in the review need to be described explicitly in the protocol.

Is the rationale for, and objectives of, the study clearly described?
Yes

Is the study design appropriate for the research question?
Yes

Are sufficient details of the methods provided to allow replication by others?
Partly

Are the datasets clearly presented in a useable and accessible format?
Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Environmental and Public Health including water, sanitation and hygiene.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 29 May 2020

https://doi.org/10.21956/aasopenres.14158.r27452

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Batsirai Majuru
World Health Organization, Geneva, Switzerland

The paper outlines a protocol for a scoping review of the links between sufficiency of water supply

and water-borne diseases in cities in the African region. In the protocol, the authors propose to conduct a search of both peer reviewed and grey literature on water sufficiency in African cities of >500,000 residents and 'ten emerging water-borne diseases'.

The authors attempt to address pertinent questions regarding water supply in the African region. However, the protocol in its current state reads like a decent initial draft, that now requires refinement and sharpening. There are several areas that are unclear. I have tried to offer what I hope is useful criticism.

The rationale for, and objectives of the study are somewhat unclear.
Per the protocol, the question to be answered is: 'what is the water sufficiency in cities in Africa and what is the correlation with water-borne diseases?' There are several concerns with the scope, definition of terms, and assessment criteria that make the rationale and objectives of the review somewhat unclear. These are outlined below.

The study design is not entirely appropriate for the research question.

The protocol requires further development and elaboration, primarily in the outcome variables of interest i.e. the waterborne diseases. The central idea in the protocol seems to be linking water insufficiency to the 'ten emerging waterborne diseases'. There are several concerns here.

1. The terminology needs to be clarified and standardized:
   -Diarrhoea is a symptom of several diarrhoeal diseases, including cholera and typhoid. Classifying it as a disease in itself is inaccurate.
   -Gastroenteritis is a set of symptoms (including diarrhoea, vomiting, nausea) arising from intestinal infection, so again, classifying it as a disease in itself is inaccurate.
   -*Cryptosporidium* and rotavirus are microorganisms / aetiological agents that cause diarrhoeal diseases, but are not diseases in themselves.
   -Guinea worm is a parasite, not a disease in itself. Diarrhoea is not a typical symptom of dracunculiasis (guinea worm disease).

2. What criteria were used to classify the 'emerging' diseases? This should be clearly described.
   - The question whether the diseases / symptoms / infectious agents listed in the protocol are 'emerging' is highly debatable. The paper cited on some of the said emerging diseases is from 16 years ago - it is fair to say that the landscape has changed a lot since then.
   - The GEMS 2013 study on aetiology of moderate-severe diarrhoea in low-income countries highlighted rotavirus, ETEC, *Cryptosporidium* and *Shigella* as the main pathogens of concern. There are likely more recent studies on this, which the authors are advised to look up.
   - Guinea worm disease / dracunculiasis has been eradicated in most countries, with about 30 cases per year (sometimes less) now reported from 3 or 4 countries in Africa, so it is unclear how it could be termed an emerging disease.

3. If the hypothesis is that water insufficiency leads to waterborne disease, how is the insufficiency determined? E.g. if City X has a published water rationing schedule in which water is supplied 12 hours per day for 7 days a week, vs City Y that intermittently supplies water 2 days a week - are the households in both cities water insufficient? I have no bright ideas on this, but it may be food for thought.

4. Most diarrhoeal cases in literature are self-reported, thus aetiological info will likely be limited.
   - Is there some weighting that would be assigned to studies based on the depth of information on the waterborne disease(s) provided? Studies reporting on the aetiology of the diarrhoeal disease may arguably carry more weight than those only reporting diarrhoea / gastroenteritis, which may not necessarily be waterborne.

Some definition of terms and scope is required for the review to be replicated by others.

It is unclear how 'water sufficiency' is defined within the scope of the review. E.g. for households living in slums, water insufficiency may arise from the slum not being connected to the network. Are they within the scope of the review?
Water deficiency, water scarcity and water insufficiency are used throughout the protocol. Do these terms all have the same meaning within the context of the review?

Other comments:

1. What is the reference for the 53% of diarrhoeal cases being from Africa? The paper by Bain *et al.* cited as ref #13 actually reports 53% of water sources in Africa being faecally contaminated, but does not refer to this 53% as the diarrhoeal disease burden from the African region.

2. Table 2, variable 14 lists 'consumer' under 'Main source of water scarcity metric'. What does this mean? How are consumers sources of water scarcity?

3. Water scarcity is not the only reason for intermittent supply. See for example review by Galaitsi *et al.* (2016[1]).

4. In the abstract, sentence 2: The 2015 statistic is not static, so somewhat inaccurate to quote as: 'As of 2015, xx people do not have access to safe drinking water'. Actually, the most recent estimate is that 1 in 3 do not have access to safe drinking-water.

References

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Is the rationale for, and objectives of, the study clearly described?

Partly

Is the study design appropriate for the research question?

Partly

Are sufficient details of the methods provided to allow replication by others?

Partly

Are the datasets clearly presented in a useable and accessible format?

Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public health, water quality, water policy and regulation

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.